# SEWAGE DISPOSAL UNDER RURAL CONDITIONS.

## SOIL POLLUTION AND THE PRACTICAL USE OF THE L. R. S. METHOD FOR EXCRETA DISPOSAL IN THE COUNTRY AND SUBURBS.

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In our effort to find a means for the sanitary disposal of human excreta where sewer connections are impossible and where sufficient dilution for sewage in streams can not be found, especial attention has been given to the system known as the L. R. S. method of excreta disposal, as this method promised to give less need for scavenging than any other. Suburban and rural dwellers have been encouraged to install these tanks and especial attention has been given by the department of health to designing and locating tanks for use with privies and with plumbing installations. The construction of many was supervised by an officer of the department. In 1913 we designed for a local contractor a set of L. R. S. tanks to be made of reinforced concrete, and since that time several hundred such tank sets have been constructed and installed in the county, and a great number have been constructed for use in other sections of the South.

Observations made on the use of these tanks during the past four years have led us to believe that the L. R. S. method offers the most satisfactory solution of the rural excreta disposal problem that has yet been devised. When tanks of proper construction and properly located are installed either for privy use or use with plumbing installations, we find that their continued use with proper care gives almost perfect results with our soil. None of the tanks in use have required scavenging except when connecting pipes have become stopped or the tank sets have been used beyond their capacity. Our experience during the past four years has led us to adopt in practice the following standards:

The capacity of the sludge tank is determined on the basis of 3 cubic feet for each user under privy conditions, and 5 cubic feet for each user when the tanks are connected with a plumbing installation.

Waste from baths and kitchen sinks should not be discharged into the sludge or the effluent tank. The waste from the kitchen sink interferes seriously with septicization and the bath waste supplies too much water. A great number of our tanks receive the bath waste and work satisfactorily, but no tank works satisfactorily that receives waste from a kitchen sink. It is our practice to connect the kitchen-sink waste into the drain from the effluent tank.

We have observed the best results in tanks that have a relatively small sludge mat area. Diameters of from 30 to 36 inches at the water line with a depth adjusted to the capacity desired in the cylindrical tanks work best. The effluent tank should be similarly designed and should not be less than one-half the capacity of the sludge tank.

When tanks are used with plumbing installations, the inflow pipe from the house should discharge by vertical drop not less than 2 feet below the water line. The pipe discharging into the effluent tank from the sludge tank should rise vertically from a point not more than 18 inches from the bottom of the tank and should discharge into the effluent tank not less than 18 inches below the water line. The outflow from the effluent tank should rise vertically from a point not more than 12 inches from the bottom of the effluent tank and should discharge near the surface of the ground into a tight line of tile pipe, or other tight conduit, leading to a contact bed located with due regard for the proximity of cisterns and wells and some distance away from the dwelling.

The contact beds that we are using are constructed of loose stones or shells in a ditch 2 feet deep by 18 inches wide, near the surface of which is laid a line of agricultural drain tile that is continuous with the effluent drain. The extent of this bed is determined by the amount of effluent to be treated. Wherever possible we persuade the owner to refrain from covering the bed with earth, leaving it open for the ingress of fresh air.

The tanks must be thoroughly waterproof both inside and out to protect them from seepage from without in, and the bottoms in concrete tanks should be made continuous and in one piece with the sides. If there is seepage of ground water into the tanks, the effect will be that of overloading.

Both privy tanks and tanks used with plumbing installations should be filled with water to the level that is reached when the tank is in full use before beginning to use them. Two or three pails full of fresh horse manure should be placed in the sludge tank.

Tanks used with plumbing installations should be tightly covered and operated without other ventilation than the house stack. Handholes should be located in the inflow pipe at the point of ingress to the sludge tank and in the horizontal pipe connecting the two tanks to facilitate rodding in case of stoppage. These handholes should be supplied with stoppers that can be tightly sealed.

Privy tanks should be constructed so that the seat with its lid shall rest upon the top of the tank itself and the lid should be made to close automatically when not in use and to cover the hole as closely as possible to prevent the ingress of flies. A vent not less than 3 inches in diameter should be carried from the tank through the roof of the privy house, and this vent should be screened to prevent the possibility of flies finding their way down the vent. Privy tanks should be kept filled with water to the level of the outflow at all times and when flies gain access kerosene should be applied to the surface of the mat to prevent fly breeding and feeding. The kerosene should be sprinkled on the mat in order that as little of it as possible

may reach the underside of the mat surface. In all other respects privy tanks are installed in the same manner as tanks for use with plumbing installations.

We have attempted to gain an idea of the extent to which the use of these tanks protects the soil from widespread pollution. The method used was suggested by Prof. Earle B. Phelps, of the United States Public Health Service. The data secured is, of course, inconclusive and applicable only to the soils of this section. We endeavored to make the tests as severe as possible, taking samples of ground water only in such locations as were so saturated that water could be obtained by driving a pipe not more than 15 feet into the ground and attaching the pump to the top. These shallow-driven pumps were pumped only to the extent of determining that a supply of water had been reached and were then permitted to stand two or three days before samples were taken. When the samples were taken only enough water was pumped off to clear the pipes of that which was either put into them to start the pump or that which had remained standing in the pipes since they were last pumped. Half the samples were taken at plants using privy tanks and the remainder at plants using septic tanks with interior plumbing installations. By reference to the table it will be noticed that in all cases the contact beds were within 10 feet of the effluent tank, and none of these plants had been in use less than six months.

Table 1 gives the essential physical data of the plants and Table 2 the data of the test wells and results of examinations. The *B. coli* are reported as positive (+) or negative (0) in the various dilutions.

TABLE 1.—*Description of plants.*

PRIVY TANKS.

| Plant No. | Date. | Soil.[1] | Plant in use. | Remarks. |
|---|---|---|---|---|
| | | | *Mos.* | |
| 1 | Sept. 18, 1916 | S/C | 24 | Delgado School (boys). |
| 2 | ....do | SC | 24 | Railroad section house. |
| 3 | Dec. 15, 1916 | Soft SC | 18 | Residence. |
| 4 | ....do | S | 24+ | Kindergarten. Plant overloaded. |
| 5 | ....do | S | 24 | Delgado School (girls). |
| 6 | Dec. 20, 1916 | SC | 6+ | East Wilmington School. |
| 7 | Dec. 22, 1916 | SC | 24 | Residence. |

SEPTIC TANKS.

| | | | | |
|---|---|---|---|---|
| 8 | Dec. 22, 1916 | L/SC | 6 | Soil poorly drained. Samples from near a drainage ditch. |
| 9 | Dec. 21, 1916 | L/C | 9 | Nursery farm. Soil heavily manured. Drainage poor. |
| 10 | ....do | L/C | 7 | Drainage poor. |
| 11 | ....do | L/C | 7 | Drainage poor. Drainage ditch nearby. |
| 12 | Jan. 6, 1917 | SC | 8 | |
| 13 | ....do | SC | 8 | |
| 14 | ....do | SC | 12 | Swampy ground and undergrowth. |

[1] S=sand; C=clay; L=heavy loam; S/C=sand underlaid with clay; SC=sand and clay.

NOTE.—Distance from effluent tanks to nitrification bed generally 10 feet.

TABLE 2.—*Results of examinations of ground water from test wells driven near nitrification beds of privy tanks.*

| Plant No. | Well No. | Distance from contact bed. | Depth. | Bacteria per c. c. on plates incubated at— | | B. coli— | | |
|---|---|---|---|---|---|---|---|---|
| | | | | 20°. | 38°. | 10 c. c. | 1 c. c. | 0.1 c. c. |
| | | *Feet.* | *Feet.* | | | | | |
| 1 | 1 | 0 | 9 | ..... | 60 | 0 | 0 | 0 |
| | 2 | 10 | 7 | ..... | 30 | 0 | 0 | 0 |
| | 3 | 20 | 7 | ..... | 10 | 0 | 0 | 0 |
| 2 | 1 | 0 | 8 | ..... | 40 | 0 | 0 | 0 |
| | 2 | 15 | 8 | ..... | 20 | 0 | 0 | 0 |
| | 3 | 30 | 8 | ..... | 20 | 0 | 0 | 0 |
| 3 | 1 | 0 | 10 | 183 | 80 | + | + | 0 |
| | 2 | 10 | 10 | 72 | 26 | 0 | 0 | 0 |
| | 3 | 20 | 10 | 39 | 8 | 0 | 0 | 0 |
| 4 | 1 | 0 | 8 | 2,200 | 1,200 | + | + | + |
| | 2 | 10 | 8 | 1,700 | 600 | + | + | 0 |
| | 3 | 20 | 8 | 1,100 | 450 | + | + | 0 |
| 5 | 1 | 0 | 8 | 145 | 85 | + | + | 0 |
| | 2 | 10 | 8 | 120 | 40 | + | 0 | 0 |
| | 3 | 20 | 8 | 120 | 30 | + | 0 | 0 |
| 6 | 1 | 0 | 11 | 60 | 5 | 0 | 0 | 0 |
| | 2 | 10 | 14 | 45 | 3 | 0 | 0 | 0 |
| | 3 | 20 | 10 | 60 | 12 | + | 0 | 0 |
| 7 | 1 | 0 | 10 | 80 | 40 | + | 0 | 0 |
| | 2 | 10 | 10 | 60 | 25 | 0 | 0 | 0 |
| | 3 | 20 | 10 | 42 | 15 | 0 | 0 | 0 |
| 8 | 1 | 0 | 12 | 160 | 90 | + | + | + |
| | 2 | 10 | 13 | 36 | 15 | 0 | 0 | 0 |
| | 3 | 20 | 13 | 145 | 110 | + | + | + |
| 9 | 1 | 0 | 10 | 600 | 250 | + | + | 0 |
| | 2 | 10 | 10 | 800 | 350 | + | + | 0 |
| | 3 | 20 | 10 | 600 | 300 | + | + | 0 |
| 10 | 1 | 0 | 7 | 200 | 100 | + | + | 0 |
| | 2 | 10 | 7 | 300 | 130 | + | + | 0 |
| | 3 | 20 | 8 | 300 | 80 | + | + | 0 |
| 11 | 1 | 0 | 7 | 1,200 | 800 | + | + | + |
| | 2 | 10 | 7 | 500 | 120 | + | + | 0 |
| | 3 | 20 | 7 | 700 | 150 | + | + | 0 |
| 12 | 1 | 0 | 7 | 80 | 15 | 0 | 0 | 0 |
| | 2 | 10 | 7 | 60 | 16 | 0 | 0 | 0 |
| | 3 | 20 | 7 | 65 | 30 | 0 | 0 | 0 |
| 13 | 1 | 0 | 10 | 110 | 10 | + | 0 | 0 |
| | 2 | 10 | 10 | 90 | 60 | + | + | 0 |
| | 3 | 20 | 9 | 150 | 90 | + | 0 | 0 |
| 14 | 1 | 0 | 7 | 250 | 300 | + | + | 0 |
| | 2 | 10 | 7 | 90 | 5 | 0 | 0 | 0 |
| | 3 | 20 | 6 | 160 | 120 | + | 0 | 0 |

In presenting the results of this investigation it would be highly desirable to present a detailed investigation of the same sort on ground waters taken from the immediate neighborhood of pit privies. There being no pit privies in the county, such samples are not readily obtainable. We have, however, some striking evidence that the sandy clay soil in this section does not present a filter medium that will protect ground waters from fecal pollution.

There are in this city and in the county a great number of shallow-driven wells. Of these we have examined bacteriologically about seven hundred. The only wells of this kind that we have found free from pollution are those which are located from two to five hundred yards away from any concentrated source of pollution, stables, privies, pig styes, etc. The bacteria counts in water from these wells not so located are extremely high and the presumptive test for colon bacilli gives unfailing positive results. The drilling of

deep wells in the city and near dwellings in the county must be conducted with great care and these wells must find in the course of their descent a perfectly impervious protecting stratum of limestone through which the casing must be carried and into which an outer casing must be imperviously seated, in order to assure a continuous supply of unpolluted water even from these deep sources.

Before the introduction of the use of septic tanks at the rural schools in this county which were supplied with water from shallow-driven pumps, every such pump was found to produce polluted water. Since the introduction of the use of septic tanks at the schools, it has been necessary only to move the driven pump to a new location to obtain a supply of ground water that is free from pollution and that remains free. In two instances shallow-driven wells that were polluted when surface and pit privies were being used at schools and which we could not have removed, cleared up after the installation of the tanks and are now producing unpolluted water.

These facts lead us to deduce that where a concentrated solution of excreta is applied to the soil, as is the case with pit privies and badly kept surface privies, there is more or less widespread pollution of ground water, and wherever the protecting stratum is imperfect there is pollution of the deeper water deposits. The ground water about a dwelling or schoolhouse is very generally polluted in this section irrespective of the presence of privies and stables, as in other soils in other sections of the country. This fact must be taken into consideration in connection with the investigations herewith submitted. It is remarkable that any water samples taken in the locations from which these samples were obtained should prove to be unpolluted in any of the quantities used for investigation.

Perhaps the only deductions that are warranted from this investigation are that the use of these L. R. S. tanks has made no material addition to the normal soil pollution about the buildings, and, in the light of the experience quoted above in connection with unprotected excreta disposal, that the amount of septicization accomplished in them produces an effluent very much less liable to pollute soil than any other process of treatment that it is possible to use with so little expense and trouble. In our experience we have had no reason to regret having encouraged the widespread use of the L. R. S. tanks. There have been, of course, numerous complaints about their action, but these complaints have invariably arisen from the stench which results from leaving privy tanks open, failure to keep the water at the proper level in the tanks, and failure to provide proper ventilation for the tanks. Trouble with tanks used in connection with plumbing installations has invariably arisen from two sources—overcrowding and the admission of kitchen sink waste to the sludge tank.

In a number of instances, contact beds have been badly located, the tendency being to locate the contact bed too near the tank and, as follows, too near the dwelling. This is evidently in order to save the expense of installing a line of tight pipe to convey the effluent to a more favorable place of deposit. Notwithstanding this, no complaints have reached this office in which the contact bed was the source of complaint.

## ANOPHELES PUNCTIPENNIS.

### A NOTE ON ITS ABILITY TO SERVE AS A HOST FOR PLASMODIUM FALCIPARUM.

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The susceptibility of *Anopheles punctipennis* Say to infection with the parasites of subtertian malaria has heretofore not been established in studies in connection with malarial investigations by the United States Public Health Service. In a previous intensive study,[1] negative results were obtained, following attempts at transmission through repeated bitings of two human subjects by mosquitoes previously given multiple feedings of blood of gametocyte carrying patients; these experiments also included the dissection of 219 specimens, all of which were negative.

On account of the apparent ease with which *Anopheles punctipennis* could be infected with the parasites of tertian malaria, it might be inferred that this mosquito exhibited a specific predilection similar to that reported for *Anopheles quadrimaculatus* and *Anopheles crucians* by local investigators. In a further series of experiments recently conducted in New Orleans, *Anopheles punctipennis* has proved easily infectible with *Plasmodium falciparum* Welch. Of one series of 16 mosquitoes, given a single feeding, one became infected; in a second group of 36, given a variable number of feedings, 13 infections resulted; in the two groups, 27 per cent of infections were observed. Of 8 examples of *Anopheles quadrimaculatus* used as controls, 4 developed infections.

[1] *Anopheles punctipennis* Say: Its relation to the transmission of malaria. Report of experimental data relative to subtertian malarial fever, by M. Bruin Mitzmain, United States Public Health Reports, Feb. 11, 1916.